Some member agencies of the Interagency Program have been reluctant to facilitate basic research. Nevertheless, the Interagency Program as an organization continues to support research that addresses fundamental questions with potential management implications. The demise of the Research Enhancement Program was an unfortunate setback in furthering this aim, although we believe that program could have been integrated better with ongoing Interagency Program investigations.

Recognize Inherent Uncertainties and Limitations

An ecosystem is an extraordinarily complex thing, and complete understanding will never be achieved. The answer to any question will carry some degree of uncertainty, and that uncertainty should be made explicit at every stage in the use of the information. Nevertheless, uncertainty should be interpreted appropriately. When the "fish-X2" relationships were published (Jassby *et al* 1995) and used in supporting salinity standards, debate arose around the fact that these relationships explained only some (often less than half) of the variance in the data. This has been cited time and again as evidence for the importance of "other factors". However, we believe this suite of relationships may be unique among all the world's estuaries in the degree to which estuarine-dependent species respond to flow. The underlying data may be too variable to allow uncertainty to be reduced, and even if other factors are operating, we may never be able to observe them. That is, the finding that flow or X2 accounts for "only" 36% of the variance in early survival of striped bass does not imply that the remaining variance is to be accounted for by factors that can be measured and possibly controlled, such as the concentration of toxic substances or the operation of power plants. It could mean instead that the observations used to develop the indices have only limited precision or that other factors are in operation that are unlikely to be observed.

Uncertainty in the findings of scientists is one of the greatest frustrations of policy-makers who have to rely on scientific input. The best a scientific agency can do is to couch answers in ways that depict the degree of reliability of a certain result. This means that in addition to predicting the outcome of some management action on the ecosystem, the agency should also address the probability and the consequences of other outcomes.

Recognize the Complexity of the Ecosystem

Many of the investigations in the bay/delta system are conducted to determine causes of observed changes in the system and, in most cases, single causes are sought. Such concentration on single factors is an outdated approach (*ie*, reductionism) that ignores the complexity of the ecosystem. Multiple causative factors can operate simultaneously or vary stochastically in relative importance among years, rendering the pursuit of single-factor hypotheses pointless (Bennett *et al* 1995). Furthermore, the system changes continually through new introductions, global warming, and other natural and anthropogenic factors.

Recognize the Limitations Inherent in "Expert Opinion"

In fisheries science in particular, great reliance is placed on the opinions of experts. Such reliance seldom incorporates checks on the accuracy or durability of these opinions, nor does it incorporate peer review. Nevertheless, history is replete with examples in which expert opinion has proved wrong. There is no avoiding the use of expert opinion in situations demanding immediate answers, but there are ways to validate that opinion; for example, by designing and conducting *post-hoc* investigations to test predictions of experts.

Expert opinion is most valuable when used in combination with experimental results to interpret data. An expert with a genuine understanding of the ecosystem may be able to discern which of several potential alternative causes of a pattern is most likely to be operating. However, the opinion of that expert should be guided not only by personal experience but also by the experience of others, learned through collaboration and communication with peers. Thus, the use of expert opinion in formulating policy should rely heavily on the principles identified above.

It is difficult to evaluate the ability of the Interagency Ecological Program to deal with the previous three issues. We see several problems in the way the program responds to these issues, and also several encouraging signs. The main problem is that many scientists in Interagency Program seem to have formed opinions about the workings of the system that do not respond to new information. Counteracting that tendency, though, is the willingness of the Interagency Program to encourage alternative views.

Managing the complex bay/delta system is never going to be easy. As California's population grows and the demand for water increases, opportunities to improve conditions in the ecosystem must rely increasingly on actions not requiring fresh water. The relative effectiveness of these actions should be forecast and determined using the best possible scientific approach and in the context of a good understanding of how the ecosystem works. We hope this editorial will stimulate thoughtful discussion about these issues within the Interagency Program, and that it will lead to refinements in the way the program conducts its science.

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Invasion of the Estuary by Oriental and European Crabs

Kathleen Halat and Kathy Heib

Two recent San Francisco estuary invaders, the Chinese mitten crab (*Eriocheir sinensis*) and the green crab (*Carcinus maenas*) are now abundant and well established in the estuary. Both were introduced within the past 10 years and have a potential to greatly impact the ecosystem. However, their life histories, preferred habitats, and potential impacts are very different.

The Chinese mitten crab is native to rivers and estuaries of China and Korea along the Yellow Sea. These crabs are catadramous, as juveniles grow and develop in fresh water and adult crabs migrate to sea to reproduce. Mitten crabs were first captured in bay shrimp trawls in South Bay during winter 1993, and the number of adult crabs captured by shrimp trawls and several sampling programs has increased each year. Juvenile mitten crabs are distributed throughout most of the tidal sloughs and creeks in the South Bay area, occurring up to 30 miles inland. In tidal areas, burrows are common where there are steep banks high in clay content and lined with vegetation. Densities of juvenile crabs as high as $25/m^2$ occur in some sloughs. Their burrows have accelerated bank erosion rates and slumping in other areas. Over time, the burrowing could pose a serious threat to the structural integrity of delta levees. In addition, in its native range, the mitten crab is secondary host to the oriental lung fluke, a debilitating parasite that can affect humans. Negative spatial interactions between mitten crabs and the introduced red swamp crayfish have been observed in the field; crayfish abundance appears to be negatively correlated with the presence of mitten crabs. Mitten crabs have a wide range of physiological tolerance and can survive out of water for at least a week, increasing likelihood for its transport and establishment. Adults have been captured recently at the SWP and CVP pumping plants.

The green crab is native to the Atlantic coast of Europe and was first collected in South Bay in 1989 or 1990. Its distribution expanded rapidly, and by 1994 green crabs were collected throughout the lower estuary, from South Bay to Carquinez Strait. Green crabs reportedly tolerate a wide range of salinity (5-33 ppt), but we have not collected them at less than 16 ppt. Green crabs primarily inhabit intertidal and shallow subtidal areas; there is some movement to deeper water in winter. Larvae hatch in winter, juveniles settle in spring, and both males and females are mature at 1 year (40 to 50 mm carapace width). The green crab is a voracious predator, consuming primarily bivalves, polychaetes, and small crustaceans. Competition for food may impact shorebirds and other intertidal or shallow subtidal predators, such as the Dungeness crab. The green crab may also compete with juvenile Dungeness crabs for space. Finally, green crabs have consumed small Dungeness crabs in the laboratory, leading to the hypothesis that a large green crab population could decimate a Dungeness crab year class.